Transport Canada Transports Canada

BC Transit

TP 7657E

VANCOUVER COMPUTERIZED SCHEDULING / BROKERAGE DEMONSTRATION PROJECT

Final Evaluation Report

Prepared for the
Transportation Development Centre
and BC Transit

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by TransVision Consultants Ltd.

March 1987

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VANCOUVER COMPUTERIZED SCHEDULING/BROKERAGE DEMONSTRATION PROJECT: FINAL EVALUATION REPORT

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Prepared for the
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and BC Transit
by Tom Geehan, TransVision Consultants Ltd.
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17. Abstract

In March 1985, the Transportation Development Centre of Transport Canada and British Columbia Transit initiated a jointly-sponsored demonstration of computerized scheduling/ brokerage systems in order to improve the quality and cost-effectiveness of transit services for disabled persons.

Two microcomputer-based systems were demonstrated. One of the systems operated on a local area network and used low-cost graphical display technology to improve the scheduling/dispatching function in special services. The other system provided scheduling assistance through a tabular display of schedules and was a multi-user system.

This report provides an overview of the project, focusing on the two microcomputer applications. The project approach and organization, applications setting, implementation procedure and impacts, results and conclusions of the project are described.

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SUMMARY

In March 1985, in order to foster the development of technology to improve transportation services for elderly and disabled persons, the Transportation Development Centre of Transport Canada and British Columbia Transit initiated a jointly-sponsored, two-year, scheduling and brokerage demonstration project in Vancouver.

The specific objective of the demonstration project was to improve the quality and cost-effectiveness of transit services for the disabled through the selection, implementation and demonstration of computerized scheduling/brokerage systems in the Vancouver region, with particular emphasis on the best application of microcomputer technology to the personalized form of transportation offered by special transit services.

Brokerage systems are designed to coordinate the supply of special transit services and stimulate increased transportation efficiency. Coordination is a multifaceted concept. In its broadest sense, coordination occurs whenever any two organizations take each other into account in their decision making. One simple coordination activity in special transit services involves the sharing of information about client trip needs. Another coordination activity involves the sharing of information about the actual delivery of services to clients. It is at this level that resources are expended and the potential benefits of coordination are greatest.

Computer systems are designed to assist special transit operators by improving the handling of information. Information is an important aspect in the operation of special transit services. The manner in which information is dealt with determines to a large extent the efficiency of the operation, the quality of the decision-making, and the level of service

implement with its greater information requirements (for mapping and display of trip requests and internal travel time calculations) but has greater potential for future enhancements due to its program structure.

The next step was to provide the rest of the operators in the Vancouver region with one or the other of the computer systems. This process is presently ongoing and involves letting the individual operators try out each of the systems and allowing them to select the one that best meets their individual methods and needs. Any operator, selecting a computer system, would probably go through the same process: (1) analysis of their needs, (2) investigation of the alternatives, and (3) selection of a system that best meets their needs.

The final proposed step, after providing the operators with appropriate hardware and software, was to use an electronic communications network (such as a wide-area local area network) for coordinating services between operators, especially for interzonal travel demands. The network was to be used to facilitate the matching of travel demands to the most appropriate service option by the operators themselves, without the introduction of an intermediary regional operating authority. Unfortunately, due to time constraints, the electronic coordinating network has not been tested.

The end products of the demonstration project included: several computer software packages for special transit service operators, including user manuals and tutorial programs; a report on computer-aided scheduling of special transit services in Canada; a report on the demonstration project; and an audio-visual presentation on the results of the project.

The demonstration project, which concluded in March 1987, illustrated the feasibility of using microcomputers in smaller custom transit services. A reduction in operating costs of approximately five percent was achieved. The benefits easily exceed the costs of acquiring computers. The project also illustrated the difficulties involved in developing new systems and the ease with which custom transit operators can adapt to a new technology and use it to improve the service provided to their clients.

SOMMAIRE

En mars 1985, voulant encourager la mise au point de technologies susceptibles d'améliorer les conditions de déplacement des personnes âgées et des handicapés, le Centre de développement des transports, de Transports Canada, et British Columbia Transit ont lancé un projet conjoint d'exploitation expérimentale d'un système de régulation/gestion des services de transport adapté à Vancouver.

Ce projet avait pour objectif précis d'améliorer la qualité et la rentabilité des services de transport adapté par la sélection, la mise en place et l'expérimentation de systèmes informatisés de régulation/gestion dans la région de Vancouver, l'accent étant mis surtout sur l'exploitation optimale de la technique micro-informatique dans le domaine des services de transport adapté, qui se caractérisent par la prestation d'un service éminemment personnalisé.

Ces systèmes ont pour fonction de coordonner l'offre de transport adapté et par là d'améliorer la productivité des services concernés. La coordination est une activité qui peut prendre plusieurs formes. Dans son acception la plus large, elle caractérise toute situation où deux entreprises tiennent compte l'une de l'autre dans les décisions qu'elles sont appelées à prendre. Dans le domaine des services de transport adapté, elle pourra se résumer au partage des informations concernant la demande de transport exprimée par la clientèle, mais elle pourra aussi s'étendre au partage des données sur les demandes de transport effectivement remplies, une information d'autant plus utile qu'elle renseigne sur les ressources réellement engagées.

L'informatisation des entreprises de transport adapté vise essentiellement à améliorer leurs opérations par une meilleure maîtrise de l'information. Tout le monde sait que cette dernière constitue la cheville ouvrière de toute entreprise de transport adapté et que de la qualité du traitement de cette information dépend dans une large mesure l'efficacité de l'exploitation, la qualité des décisions prises et le niveau de service que

L'entreprise choisira l'un ou l'autre selon l'expérience qu'il a déjà des deux modes d'exploitation en question. En général, le DART Manager Graphics pourra s'avérer un peu plus difficile à mettre en place, vu les informations plus détaillées dont il a besoin pour fonctionner (notamment en ce qui concerne l'affichage des demandes de déplacement en surimpression sur une carte de la zone desservie et les calculs internes de temps de déplacement). Toutefois, il offre plus de possibilités d'extension grâce à la structure de sa programmation.

La deuxième étape a été d'équiper les autres entreprises de transport adapté de la région de Vancouver de l'un ou l'autre des deux systèmes proposés. Cette étape est en cours et suppose qu'on laisse chaque entreprise expérimenter les deux systèmes de manière qu'elle puisse choisir en toute connaissance de cause le système qui répond le mieux à ses besoins. Afin d'opérer ce choix, chaque entreprise doit en principe suivre un acheminement identique: 1) analyser ses besoins; 2) étudier les diverses solutions en présence; et 3) choisir le système qui correspond le mieux à ses besoins.

La dernière étape au programme prévoyait d'interconnecter les diverses entreprises grâce à un réseau de télécommunications électroniques (un réseau local étendu) en vue de coordonner leurs prestations de services, notamment au sujet des demandes de déplacements interzones. Ce réseau devait faciliter la sélection, par les entreprises elles-mêmes, de l'entreprise la mieux placée pour répondre à une demande de déplacement, ce qui aurait permis de se passer d'une instance intermédiaire de régulation régionale. Malheureusement, par manque de temps, il a été impossible de mettre à l'essai ce réseau de coordination électronique.

Les produits tangibles livrés par le contractant ont été les suivants: plusieurs progiciels de régulation/gestion de services de transport en commun adapté, accompagnés des guides d'utilisation et programmes d'initiation appropriés; un rapport sur la régulation assistée par ordinateur des services de transport adapté au Canada; un rapport sur le projet de démonstration et, enfin, une production audio-visuelle présentant les résultats de l'expérience.

Le projet de démonstration, qui a pris fin en mars 1987, a montré l'utilité des micro-ordinateurs pour la régulation informatisée des services de transport adapté. Il a permis de dégager une économie d'exploitation d'environ 5% qui permet d'amortir rapidement le coût de l'informatisation de l'entreprise. L'expérimentation a également permis de mettre en évidence, d'une part, les difficultés inhérentes au développement de nouveaux système et, d'autre part, la facilité d'adaptation des entreprises concernées à une nouvelle technologie qui leur permet d'améliorer le service à la clientèle.

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1. INTRODUCTION

Special transit services for disabled persons, by their very nature, are extremely management and labour-intensive. Since they are a door-to-door service, each client and each of their trip requests has to be accounted for. Improvements in productivity and efficiency rely heavily on improvements in operations management -- which is usually performed manually. Much of the operations management effort is concerned with recording, retrieving, exchanging and displaying information relating to the trip requests. The manner in which information flows are dealt with determines to a large extent the efficiency of the operation, the quality of the decision-making, and the level of service that can be offered to the users of the system.

Improvements and expansion of transit services for the disabled are often limited, not by demand (which is usually greater than the supply), but by the efficiency of operations. In fact, these services tend to rely fairly heavily on management and control of the demand by means of eligibility criteria, ride prioritization and/or other service constraints. To provide effective and efficient service with appropriate improvements in service quality requires better responsiveness in dealing with the demands and/or better control and management of the supply of services.

The extent to which computers and/or other new technology can aid in the decision-making process involved in managing special transit services is a complicated issue. But it is in this operations management area -- and, particularly, scheduling/dispatching -- that many worthwhile benefits are anticipated. Matching the supply of available vehicles with the demand for trips, and making the most effective use of limited resources, is the challenge faced daily by managers of special transit services.

Applying Computers to the Problem

Computer systems are designed to assist special transit operators by improving the handling of information. Information is a problem with all special transit services. The manner in which information is dealt with determines to a large extent the efficiency of the operation. The application of computers should improve the handling of information. In addition, computer networks are a technology designed to improve the sharing of information. Therefore, the use of networks should improve the coordination of services to meet client needs by improving the sharing of information between separate operators.

A feasibility analysis (1) was undertaken during preliminary investigations to determine a proper course of action for BC Transit with respect to the application of computerized reservation/scheduling/dispatching systems to custom transit operations in the Vancouver region. The approach was to undertake a cost-effectiveness analysis of alternative computer system configurations and, in so doing, to determine the operational and economic feasibility of computer assistance in custom transit operations.

The analysis was based on information received from various scheduling system suppliers. Anticipated benefits included: improved productivity, better quality of service, reduced administrative requirements, and better employee morale. As a result of the analysis, it was concluded that the application of computers to custom transit operations in the Vancouver Region was feasible from a technical, operational and economic viewpoint.

It was decided that the most feasible option was one in which a microcomputer system would be provided to each independent operator -- what was termed the decentralized alternative. Centralized, decentralized and coordinated options were investigated. It was also concluded from the analysis of a coordinated option that additional benefits could be achieved by investing in equipment to facilitate communications between the separate microcomputer-based systems -- essentially an electronically-networked brokerage system.

A final conclusion was that the decentralized system should be implemented in stages (in terms of both number of functions for each installation and number of installations) with adequate testing and demonstration before proceeding to the next stage -- essentially a prototyping, iterative or cyclical system development process.

Based on the conclusions resulting from the feasibility analysis, BC Transit decided to begin implementation of computer-aided scheduling systems in the Vancouver Region and, because of the potential transferability of experience offered by the microcomputer-based approach to other cities in Canada, requested Transport Canada to participate in a demonstration project.

Managing the Demonstration Project

The overall project organization consisted of a Steering Committee, a BC Transit Management Committee, a Users Group (i.e. the operators), Project Coordinator and other support and operating staff.

The demonstration project has been under the overall direction of a Steering Committee composed of representatives from the Transportation Development Centre, BC Transit, the City of Edmonton, the Canadian Urban Transit Association and the Provincial Transportation Ministries of Alberta, Ontario and Quebec.

The BC Transit Management Committee, comprised of senior BC Transit management staff, undertook overall responsibility for project monitoring, budget and contractual control, and coordination. A Users Group, consisting of the local custom transit operators, was involved in helping to design, implement and test the computer systems.

A Project Coordinator, TransVision Consultants Limited, was retained by BC Transit to provide detailed project monitoring, control, coordination and reporting for the project. Other services and suppliers were contracted for by BC Transit as required.

Allocation of Resources to the Project

The project schedule covered twenty-four months, beginning in April 1985 and ending in March 1987. Due to the prototyping approach that was used (in an attempt to optimize the computer systems in relation to user requirements and system constraints), the early versions of the computer systems were developed and implemented within about six months -- although these were not deemed to be finalized and thus suitable for distribution until March 1987.

The overall project budget was $525,000, of which $300,000 was provided by Transport Canada and $225,000 by BC Transit. This budget covered expenditures for system development for two computer systems, hardware procurement, preparation and distribution of user manuals and programs, report preparation and dissemination, BC Transit and operating company staff time on the project, and other miscellaneous cost items.

Using Technology to Meet the Needs

Two microcomputer software packages were developed and demonstrated during the project. These were made available, with appropriate user manuals and training tutorials, to other interested special transit service operators in Canada.

Report Objectives and Directions

This report is viewed not only as a documentation of the results of the demonstration project but also as an overview of the systems development effort. Therefore, a review of alternative means of accomplishing specific objectives in designing, developing and implementing computer systems is also provided.

Section 2 reviews the project setting: the manual systems that were repiaced and the alternative available computer systems. The objective of this section on the project **Setting** was to describe the specific user environment into which the computer systems must fit.

Section 3 provides a review of the organization of the demonstration project, the functions and the responsibilities of the project participants. This section on **Organization** had the objective of outlining the project management structure that was used and to identify the reasons for using this structure.

Section 4 of the report describes the overall approach to the systems development effort. The objective of this section in the report on **Approach** was to outline the approach that was used and to identify the reasons for using this approach.

Section 5 describes the specific computer system technology that was used and provides a description of the capabilities of the systems. The objectives of this **Technology** section were: (1) to describe the alternative microcomputer system configurations that are available, (2) to outline the configurations that were used and to identify the reasons for using these configurations, and (3) to describe the software packages that were developed, their capabilities and features.

Section 6 provides a review of the implementation process, the difficulties encountered and the lessons learned. The **Implementation** section had these objectives: (1) to outline the selected approach and to identify the reasons for using this approach and (2) to identify lessons for the future.

Section 7 gives the results of the evaluation of the computer systems, the benefits of computerization and a comparison of the two systems tested. The objectives of the **Evaluation** section were: (1) to describe benefits of using computerized scheduling systems in special transit services and (2) to evaluate the two scheduling systems that were developed.

Section 8 outlines the conclusions and recommendations resulting from the project. The **Conclusion** section had these objectives: (1) to reiterate the lessons learned from the demonstration project experience, and (2) to outline recommendations for future research and development work to be carried out.

2. SETTING

Understanding the setting in which project plans, actions and results take place has a key role in the overall research and development process.

Research and development of new systems is often embedded in a complex milieu that includes the sponsoring agencies, the recipient subject or user organization, the research and development team, and the social, political, and economic environment in which the new system is being implemented. Successful management of the research and development effort depends on an understanding and awareness of this project setting in order to detect change, assess its impact, and trigger changes in the system development plan.

Changes in the plan are often necessary to accommodate other external changes. In this demonstration project, partly due to the length of time involved in the systems development effort, a number of changes occurred in the project setting that impacted the plan. These included:

- changing ideas about the nature and use of any new computer system and attitudes towards these changes;
- changing technologies for implementing the system, including changing cost/performance relationships of computers and networks;
- changing structures of one of the sponsoring agencies (BC Transit) and changing relationships of the special transit operators;
- changing characteristics and capabilities, as well as perceptions, of the system developers as the needs of the users became clearer; and
- changing characteristics and perceptions of the system by the ultimate users of the system as familiarity increased.

Special Transit in the Vancouver Region

BC Transit, a provincial crown corporation and funding agency responsible for all transit services in the Province, introduced the Custom Transit Services Program in April 1980. Prior to the introduction of this program, transportation services for handicapped persons were provided by various charitable and community organizations as a supplemental service to their other social service operations. Funding was provided by charitable donations and the Provincial Ministry of Human Resources.

As a result of the introduction of the Provincial Program, the Vancouver Region was divided into eight service areas along municipal boundaries, with a total of nine operating companies providing service within the region. All identifiable, provincially-funded transportation services for handicapped persons were incorporated into the Program.

The Program provides a policy, funding and administrative framework for the provision of custom transit services in the Province. BC Transit contracts with private companies or nonprofit societies to operate the service, supplies the vehicles and equipment, assists in administration, and is responsible for service specification, funding, planning, marketing, monitoring and evaluation activities.

recent survey (4), over half of all trips provided were similar to a taxi service without any stops -- an exclusive ride from origin to destination. Only about a third of all trips made between one and three stops.

This analysis also showed that the percentage of deadhead time (the amount of time spent when a vehicle is not carrying passengers), averaged close to fifty percent. Consideration of these stopping and deadhead characteristics illustrates the similarities between the existing custom transit service and exclusive ride taxi services -- illustrating a need for efforts to promote more sharing of rides. Ride-sharing is an important component of special services to increase productivities and reduce costs.

This analysis indicates a need to look more closely at opportunities for improvements (5) in the way that the service is managed and at the internal processes and information flows (especially in the reservation, scheduling and dispatching tasks) that are used by the individual custom transit companies in operating, controlling and monitoring the service that is offered to their clientele.

Exhibit 3: Operating Statistics for Custom Transit in the Region

SYSTEM CHARACTERISTICS

Total Population = 1,060,000
Service Area = 1260.9 sq. km.

SYSTEM STATISTICS

	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87
Actual Expenses	$3,028,673	$3,764,091	$4,114,078	$4,327,960	$4,734,278	$4,928,681
Hours of Service	168,381	169,071	171,629	172,056	179,740	199,862
Cost Per Hour	$17.99	$22.26	$23.97	$25.15	$26.34	$24.66
Total Trips	303,065	361,926	396,500	406,804	414,965	496,601
Cost Per Trip*	$ 9.99	$10.40	$10.38	$10.64	$11.41	$ 9.93
Trips Per Hour	1.80	2.14	2.31	2.36	2.31	2.48
Vehicles	76	80	83	83	89	96

OPERATOR STATISTICS (1986/87)

	Costs	Revenue	Hours	Kilometers	Passengers	Psgr/Hour
Deltassist	$ 164,139	$ 21,430	7,341	153,229	15,596	2.12
North Shore	435,786	51,845	17,839	302,848	43,803	2.46
Pacific Transit	2,262,949	234,294	91,754	1,633,966	213,885	2.33
Richmond	271,227	29,384	8,942	176,074	24,033	2.69
Surrey	402,576	49,250	19,097	334,180	40,758	2.13
Vancouver**	294,966	35,322	13,121	208,353	35,879	2.73
Western Society	967,757	128,582	36,448	697,713	104,596	2.87
White Rock	129,239	22,573	5,320	99,280	18,051	3.39
TOTAL	$4,928,661	$572,680	199,862	3,573,643	496,601	2.48

* In 1986/87, the method for charging lease fees was changed resulting in a reduction.
** In July 1986, Vancouver Custom Transit operations were taken over by Pacific Transit.

The other computer system was intended to be tested at Pacific Transit Cooperative in Vancouver. Pacific Transit had a client base of about 1000 and served 330 trips each day. It had an office staff of six: a manager, a supervisor (dispatcher), two part-time dispatchers (for week-ends and nights), a call-taker (scheduler) and a full-time bookkeeper. There were 18 vehicles in the fleet (16 vans and 2 station wagons) and there were 24 full-time and 14 spare drivers.

Unfortunately, during the implementation of the computer system, operational contracts were renegotiated and a change in the status of Pacific Transit warranted a change in venue for the computer system. The North Shore HandyDart Service was subsequently selected.

The North Shore HandyDART Service. North Shore HandyDART is operated by 3120 Ventures Limited and provides service on the North Shore, including North Vancouver and West Vancouver.

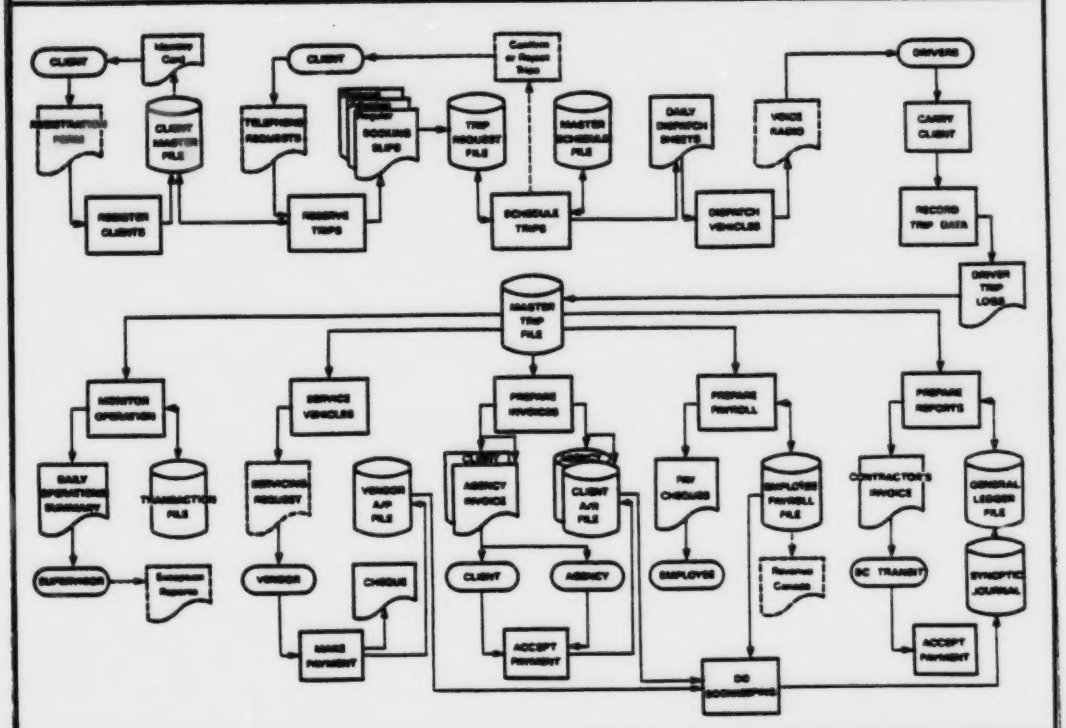
North Shore HandyDART has approximately 900 registered clients on file and provides about 150 rides per day, of which about one-third are regular subscription trips and two-thirds are advance reservation trips. Seven vehicles are used and nine drivers are employed.

The office staff consists of a part-time office manager, a part-time accountant and a full-time supervisor. The manager is responsible for staffing, administration and reporting. The supervisor does the dispatching and supervises the drivers and dispatch operation. The supervisor also accepts telephone requests, schedules trips, confirms trips and handles cancellations and call-backs. The supervisor assigns trips to the vehicles over the radio and records the vehicle assigned to each trip. The part-time accountant prepares payrolls, accounts payable and does general accounting, as well as compiling monthly operating statistics.

The supervisor prepares master schedule sheets, one for each day. The daily sheet is divided into columns for each vehicle and into rows for each 30-minute time slot. Starting with regular trips, one week prior, the schedule is developed using the master schedule as a basis. Advance reservation and on-demand requests are added in by the call-takers when they receive a request over the phone. If the request can be accommodated, the client is informed while on the phone. Driver run sheets are not prepared since the trips are dispatched by the mobile radio system to allow changes to the schedule throughout the day. Driver trip logs, however, are prepared by the drivers.

Regular subscription trips can be booked at any time. One-time advance reservation priority trips (work, medical, school or groups) can be booked up to one week ahead. Other advance reservation trips (recreational, social) can only be booked one day before. Daily on-demand trips are served if possible.

Exhibit 4: Information Flows in the Custom Transit Office



to this task is the set of origins, destinations, and desired delivery times associated with the service requests. The 'output' from the scheduling task is a set of vehicle schedules or tours consisting of a sequence of pickup and delivery stops, as well as expected arrival time for each stop.

Scheduling is a very complex and difficult task. The ability of the scheduler to generate 'good' schedules depends on a great many factors. The ability to assess the 'goodness' of any particular scheduling process depends on being able to say what the 'best' schedule would be.

Dispatching. The primary task of the dispatcher is transmitting trip details and instructions to the drivers. The secondary task involves monitoring the status of the vehicle fleet, transmitting schedule changes to the drivers, providing information to office staff, and record-keeping.

Much of the trip information can be communicated to the drivers through driver run sheets which may be printed out the night before. These driver run sheets contain each drivers itinerary for the day of service.

The generation of operating statistics and reports is another task that is cumbersome and labour-intensive. It involves the manual manipulation of the data required, mainly from the driver trip logs, which is a time-consuming and error-prone process. The driver trip logs are used since nearly all management information required for proper monitoring and customer relations depends for its accuracy and relevance on knowledge of the actual schedules. The working schedule changes considerably 'on the road' due to changing circumstances such as traffic delays, vehicle breakdowns, doctors running late and other unforeseen circumstances.

Usually, completed driver run sheets are reviewed by the operator and daily operational statistics are prepared. These are then compiled on a monthly basis and forwarded to BC Transit. In addition, the dispatcher may prepare an 'exception report' listing the no-shows, complaints, vehicle breakdowns and other incidents.

The Trip Scheduling Function

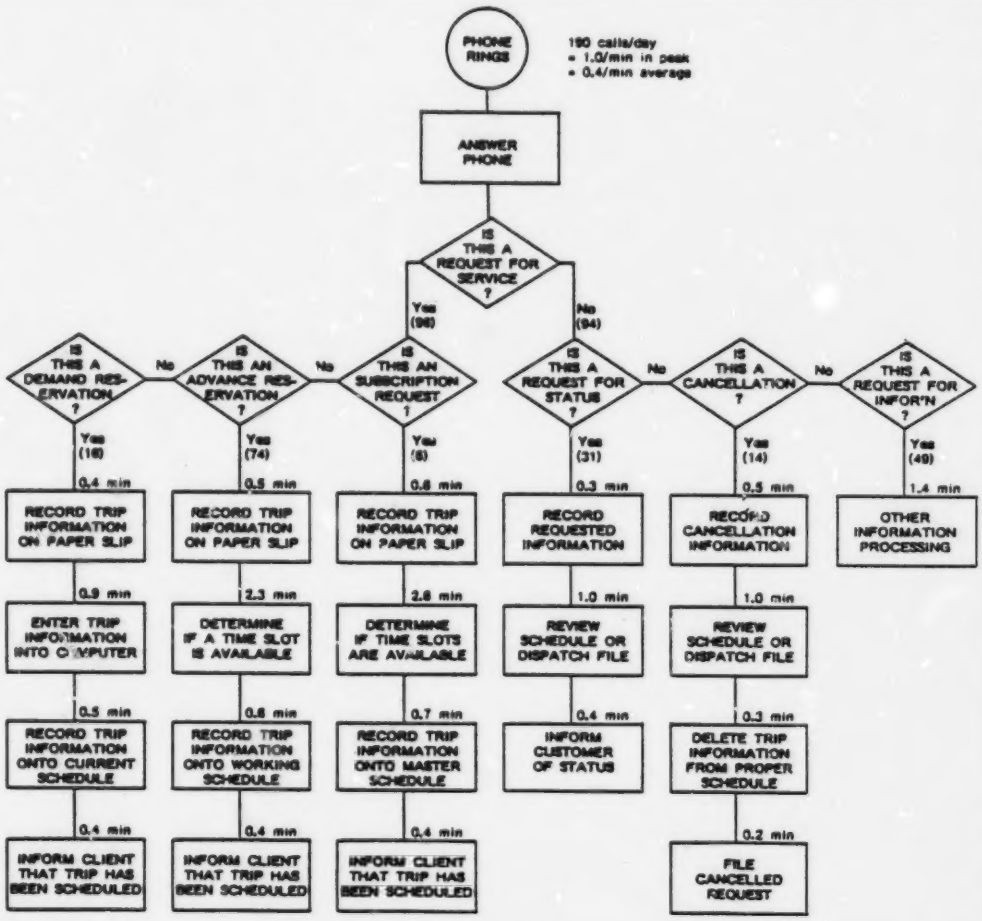
The central element of any custom transit service is the schedule, or a set of scheduled vehicle runs, for a given day of operation. The schedule contains all the necessary information for each person-trip including the time requested by the customer, the scheduled time, and, upon completion of a run, the actual time entered by the driver on his driver sheet. Most of the actions taken by the call-taker, scheduler, and dispatcher will pertain to these records.

Chronologically, the first action taken on a schedule for a given day is its creation. The scheduler will create a schedule one week in advance by copying a day's master schedule containing all the pre-scheduled subscription and pre-booked trips. The copy of the master schedule is referred to as the current or working schedule.

When a client calls to reserve a trip for a given day, the call-taker will enter the data on a trip request form (or directly onto the working schedule). Subscription trips and pre-booked trips can be requested at any time but can only be placed in the master schedule if requested more than one week in advance. On-demand reservation trips can usually be requested any time up to seven days in advance of the trip.

The scheduler will, at the proper time, try to schedule all the advanced requests received. To do so, certain data in the schedule trip record may have to be modified as needed. The modification, however, is kept to a minimum since the scheduling process is really a 'trip insertion' process -- the overall master schedule is rarely changed to incorporate a new trip insertion. The trip insertion is either accommodated or it is refused. Part of the reason for using this trip insertion process, aside from the fact that it is easier to do, is that it ensures regular clients are always picked up by the same vehicle at about the same time every day.

Exhibit 5: Information Processing in a Custom Transit Office



Based on these rates, percentages and performance times, an analysis was undertaken to determine the processes where the bottlenecks occur. The input to the analysis included:

- The number of order-takers, schedulers, and dispatchers;
- Average arrival rates of requests, measured in requests per minute, at a given level of demand load (e.g., peak period of the day);
- Average processing rates, measured in requests that can be handled per minute, at order taking, dispatching and scheduling; and
- Six percentages to distribute the arrival rate according to the type of request at order taking since the processing rates differ for each type of request.

Opportunities for Improvement

Custom transit services are extremely management and labour-intensive. Improvements in productivity and efficiency rely heavily on improvements in operations management -- which is usually performed manually. Much of the operations management effort is concerned with recording, retrieving, exchanging and displaying information. The manner in which information flows are dealt with determines to a large extent the efficiency of the operation, the quality of the decision-making, and the level of service that can be offered to the users of the system.

Improvements and expansion of transit services for the disabled are often limited, not by demand (which is usually greater than the supply), but by the efficiency of operations. In fact, these services tend to rely fairly heavily on management and control of the demand by means of eligibility criteria, ride prioritization or other service constraints. Effective control of demand with corresponding improvements in service quality requires better time responsiveness in the manner in which information flows are dealt with.

The time spent in the typical custom transit office on the various tasks is illustrated in Exhibit 7. Because of the large amount of time spent on purely administrative chores, there does not seem to be nearly enough time spent on analytical tasks such as trip scheduling. And it would be the application of custom transit office staff on these analytical tasks where the greatest benefits in the overall operation would be achieved.

APPLICATION OF COMPUTERS

To provide some answers to these questions, a feasibility analysis was undertaken in September 1984 (1). The primary purpose of the investigations was to determine a plan of action for BC Transit with respect to the application of computerized brokerage/scheduling systems to custom transit operations in the Vancouver Region.

Brokerage systems are designed to coordinate the supply of special transit services and stimulate increased transportation efficiency. In its broadest sense, coordination occurs whenever any two organizations take each other into account in their decision making. One simple coordination activity in special transit services would involve the sharing of information about client trip needs or the delivery of service to meet those needs.

Computer systems are designed to assist special transit operators by improving the handling of information. The application of computers should improve the handling of information. In addition, computer networks are a technology designed to improve the sharing of information. Therefore, the use of networks should allow sharing of information and thus improve the coordination of services to meet client needs.

Computerized scheduling/brokerage systems would, therefore, appear to be a means of stimulating increased transportation efficiency but a well-defined plan of action would be required for implementation.

The general approach in determining a plan of action was to undertake a cost-effectiveness analysis of alternative computer systems and configurations and, in so doing, determine the operational and economic feasibility of computer assistance in custom transit operations.

A Look at What Was Available

Transit services for disabled persons operate like shared-ride demand-responsive services where control of vehicles is the critical functional process. The objectives of control are to:

- minimize the wait time for pickup (wait time variance) and travel time (and travel time variance) to the destination, and
- maximize the number of passengers in the minimum number of vehicles without excessive increases in wait or travel time.

In the transit control centres, the tasks of registering clients, reserving trips, scheduling, dispatching and monitoring are undertaken with the objective of providing the maximum number of riders with good service.

- **Quebec City** - Systemoid Inc. of Quebec City, developed a registration, reservation and scheduling system for the operator in Quebec City using Powerhouse, a database management system for the DEC VAX series of minicomputers. This system uses various sorting functions of the database program to assist the scheduler.
- **Berlin** - Messerschmitt-Bolkow-Blohm developed a centralized off-line scheduling system for the Telebus service in Berlin using digital data transmission of information directly to terminals in the vehicles. This system schedules up to 2000 trips per day for 100 or more vehicles. The system is also used in Wunstorf, Germany and Friesland, Holland.
- **Stockholm** - Volvo Transportation Systems is marketing a system developed for Stockholm, Sweden. This system provides client registration, trip reservation, on-line scheduling, and optional digital dispatching functions. It schedules on-line and in real-time. The system is being expanded in such a way that it can be accessed by all operators in Sweden.
- **Sacramento** - Paratransit Software, a small software development firm located in Washington, D.C., developed a computerized scheduling package for operation on the IBM Personal Computer and it is presently in use in Sacramento, California. This system develops optimal schedules for subscription and advance reservation trips and prints driver run sheets, management and cost information, plus least cost tables to facilitate using taxis as a supplementary service.
- **Menlo Park** - Stanford Research Institute, under contract to the Urban Mass Transit Administration in the United States developed a computer-aided scheduling system using colour graphical displays to assist the scheduler in developing schedules and assigning trips. This system operates on a number of different configurations using IBM Personal Computers in a Local Area Network in order to meet the requirements of varying sizes of operators.
- **Victoria** - Dialog Business Systems, under contract to BC Transit, developed a client registration and trip reservation system for the special transit service operator in Victoria, B.C. The system operated on an Onyx multi-user minicomputer in Victoria and was downloaded to an IBM Personal Computer for the operator in Kelowna, B.C.

Alternative Functional Applications

The various functions that these systems can perform include: registration, reservation, scheduling, dispatching, recording and monitoring.

The degree of application of the computer to these functions is a useful method of defining alternatives. In each of the functions, the computer can be used to display information to assist in the decision process (computer-aided system), or it can function with little or no human decision-making assistance or intervention (computerized system).

tions for all interaction between clients and the office staff, and voice radio (as well as written) communications between the dispatcher and the drivers. The former could be, at least partially, replaced by computerized message recording and call-backs, while the latter, as mentioned, could be partially replaced by digital communications. But these are untested and unproven options.

The extent to which the computer can aid in the decision-making process involved in scheduling is impossible to answer at the present time. But it is in this area that the greatest benefits are anticipated since any improvements directly impact vehicle operating and labour costs. Only one operating system attempts to optimize the schedule (Sacramento's) although many systems have attempted to optimize the insertion of trips into an existing schedule (like Edmonton's). Whether this latter approach of inserting trips into an unchanging 'master' schedule leads to more or less efficient schedules is a question of concern.

Implicit in the undertaking of most computer applications are certain expectations that computer assistance in the scheduling task will result in increased productivities, but that computer application solely on the administrative side of custom transit will offer insufficient benefits to justify the expenditures required.

Alternative Operational Configurations

Another basic consideration is the operational configuration. This depends largely on the type of operation. In Vancouver, several alternatives, categorized by their basic operational configuration, were investigated: (1) a Decentralized System, in which a microcomputer is provided to each independent operator, (2) a Coordinated System using a central minicomputer and remote terminals for each independent operator, and (3) a Centralized System in which one operating company uses a minicomputer and provides services throughout the Region.

The alternatives are not necessarily mutually-exclusive. For example, the decentralized option could closely approximate the coordinated alternative by using multi-user or local area networked microcomputers communicating with each other through a host mainframe computer. Similarly, the coordinated option could closely approximate the centralized option by replacing the remote terminals with printers that would just print out vehicle schedules for the operating companies.

There are a number of functions that benefit from centralization in any custom transit service -- for example, marketing, planning, funding (the 'brokerage concept'). By categorizing the alternatives according to the configuration of the computer system, it is possible to analyze the question of computer assistance being one of these functions. And, if it is, the degree of centralization desired.

3. ORGANIZATION

A project is a well-defined effort undertaken to produce specified results in a given setting at predetermined times. A demonstration project is one in which the functions undertaken in the project are merged into the operation of the organization at the completion of the demonstration. Although projects vary in size, duration, and complexity, all have a specific objective; when that objective is met, the effort is complete.

A successful methodology for managing demonstration projects acknowledges these characteristics and provides a means for dealing with them in a controlled, organized manner. It is essential to maintaining control and ensuring that the projects are completed on time and within budget.

Project management is an organizational technique that has evolved to meet the need for an organizational structure that can effectively achieve short-term objectives in a rapidly changing setting. It places a project team, free from the routine activities that can dominate a manager's workday, in charge of the project. Utilizing techniques for organizing, estimating, assigning and tracking activities, they can monitor and control the project effectively.

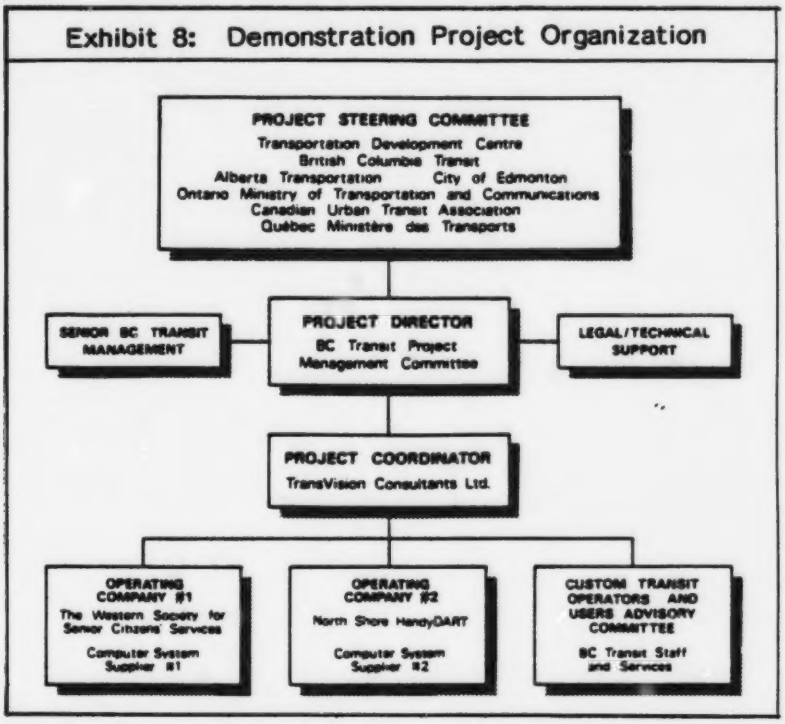
For this computerized brokerage/scheduling demonstration project, a project management organization was used that combined BC Transit staff in a matrix organization to organize, manage and control the project with consulting support staff to assist in project coordination.

The basic elements of effective project management are discussed in this chapter as they were applied to the Vancouver computerized scheduling/ brokerage demonstration project.

Demonstration Project Management

The overall project organization, consisting of a Steering Committee, BC Transit Management Committee, Users Advisory Committee, Project Coordinator and other support staff, is illustrated in Exhibit 8.

Exhibit 8: Demonstration Project Organization



The demonstration project has been under the overall direction of a Steering Committee composed of representatives from the Transportation Development Centre, BC Transit, the Canadian Urban Transit Association, the City of Edmonton, and the Provincial Transportation Ministries of Alberta, Ontario and Quebec.

The BC Transit Management Committee, comprised of senior BC Transit management staff, undertook overall project monitoring, budget and contractual control, and coordination functions for the project.

An Operator Users Group, consisting of the custom transit operators, was involved in helping to design and implement the computer systems.

A Project Coordinator, TransVision Consultants Limited, was retained by BC Transit to provide detailed project monitoring, control, coordination and reporting for the project. Other system development services, systems consultants and equipment suppliers were contracted for by BC Transit as required.

The Contribution of the Operators

The user group consisted of the operators that were selected for the testing of the systems: the staff and management of the Western Society, Pacific Transit Cooperative and the North Shore HandyDART service. Although disabled individuals were represented (Pacific Transit is operated by a disabled users group), no explicit attempt was made to involve the elderly and disabled community directly.

Because the users of the computer systems (i.e., the operators) ultimately determine the success or failure of any system, they were deeply and continuously involved in the development of the systems -- beginning with the selection of the systems. Before the final decision was made on the particular systems that would be implemented, all the operators were invited to view and comment on the candidate systems.

The most successful systems are naturally developed with this high degree of user interaction. Systems are most effective when the user suggests changes in screen designs and functions while the project team advises and the development team performs the technical task. Because of the prototyping approach used in the systems development effort, the development team was able to incorporate user suggestions in these areas.

User involvement was greatest during the initial phases of the development effort, when system requirements were defined. A workshop and seminar (6) was held for all operators at this stage -- both to educate them on the new technology and to obtain feedback for the requirements definition. After the initial definition effort, the operators regularly worked with, reviewed and approved appropriate products of the effort.

Development Team's Responsibility

In a typical systems development effort, high-level technicians from the systems and programming areas translate user requirements into a functional system design. SRI International and AIM Software Consulting were the development teams for each of the two systems respectively.

With the definition and development phases of the project, the involvement of the contract development team increased significantly. Both teams first undertook a systems analysis and design effort to define the modifications required to meet the needs of the users. The systems analysis was then used to define the contract requirements for system development and implementation.

After the systems analysis effort was approved, the development team was then responsible for the specifications, coding, testing, and implementation of the systems.

In addition, the end products of the tasks provided the basic systems documentation on a continual basis and, when combined with status reports, control reports, and other working papers, resulted in a thorough and accurate project history and project documentation manual.

Organizing Staff and Resources

Organizing resources ensures that the specific resources required (staff and equipment) are available to meet the demands of the project schedule. This was done by assigning responsibility for task completion in the work plan to the party (project or development team member) who was required to perform the task and produce the end product.

Many projects operate within limitations that influence how effectively resources can be allocated and time, staff and budget limitations had to be considered in this project. Arranging for the system developers to handle project tasks on a fixed-price basis was the most common means of containing costs, and this worked satisfactorily since the firms had a reputation for performing such projects well.

Most projects depend to varying degrees, on these three factors -- time, resources, and budget. The work plan gave the project management team an excellent tool for determining whether activities could be completed within the given limitations. When they could not, the work plan also provided the documentation required to support the need for additional resources or project modification.

The remaining functions deal with communications between the project coordinator and the project management team and/or the development team. Effective communications provided the details necessary to accurately update and modify the work plan on a regular basis.

Providing a Reporting Mechanism

A formal reporting mechanism was implemented to provide the Steering Committee and the project management team with a clear picture of the tasks being performed. Although it was not elaborate, it provided a record of performance that was used to detect problems.

The status reports reflected all the activities of the project team during the reporting period. In addition, an activity log was maintained which included: (1) a breakdown by hour of the specific tasks performed during the period and an accounting for all time allocated to the project by individual, and (2) both current and cumulative hours spent on each task with the original estimate for each task. This reminded team members of the tasks outstanding and corresponding target estimates.

understood. Many 'small' changes had a ripple effect on the entire project schedule and thus resulted in significant effort to complete.

Finally, the decision to accept or reject a change was made by the project management team in consultation with the project coordinator and/or the development team. The request was then either rejected or approved. Changes to system specifications or functions were reviewed by the users to ensure that they were still acceptable. The master schedule was often changed to allow for new or modified activities.

Establishing an Acceptance Procedure

As stated, all tasks result in the generation of an end product. Ideally, these deliverables were reviewed and then formally accepted as correct or rejected for a specific reason. This procedure was performed continually to detect errors or problems as they occurred and so that they were corrected with minimal impact to the project.

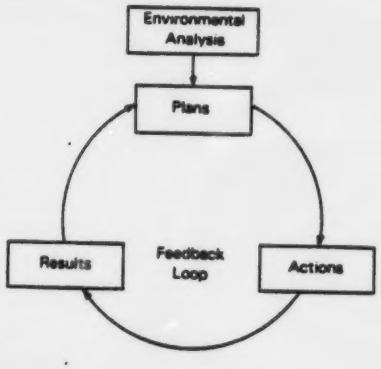
Most organizations know this review procedure as user sign-offs. Task acceptance implies careful review. The involvement of the users from the beginning of the project helped to build a good understanding of system functions and objectives, which generally resulted in a quick, accurate review of products as they were completed. Acceptance of the final product -- signoff -- was not completed until the users were satisfied with the way that the system was operating.

4. APPROACH

A demonstration project is a well-defined effort undertaken to produce specified results in a given environment at predetermined times. Planning for such a project can be categorized in several ways. The basic objective of planning, however, is to develop an approach for actions and decisions that will ensure that the project's resources are effectively and efficiently acquired and used in support of the project objectives.

Developing an approach to the project - planning - is the first important step. As illustrated in Exhibit 9, planning is a cyclic process, producing actions that cause results and learning from the results. The key role that understanding the environment plays is also shown in this figure.

Exhibit 9: The Cyclical Nature of Planning



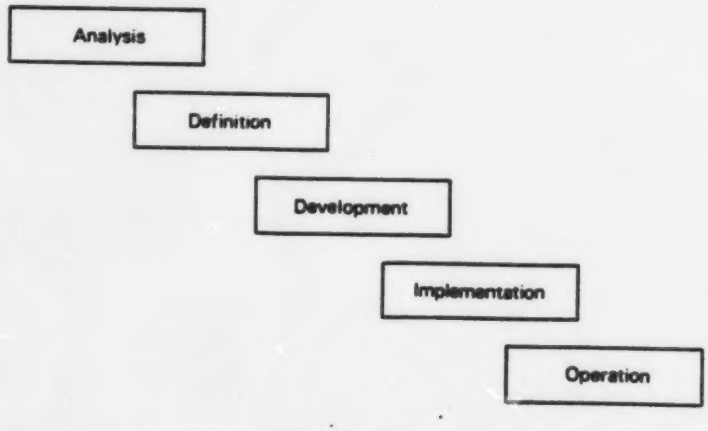
The tangible product of the planning process is a basic approach to the demonstration project -- a hierarchy of documented plans. The overall project plan states the goals and objectives, strategies and issues in the context of the understanding of the technological concept and the environment. The project approach supports the overall plan and is a road map for implementing the strategies and achieving the objectives through the effective deployment of resources. The project approach contains a work breakdown structure -- including project management plans for the project, plans for each functional area, and plans

Exhibit 10: The Phases Involved in Systems Development

PHASE	PURPOSE	DELIVERABLE
Analysis	To analyze the existing system by defining and analyzing existing and new functions.	Systems analysis report
Definition	To define application requirements and prepare a design of a proposed system solution that would meet the requirements.	Detailed design report and test strategy
Development	To develop and test all computer programs and procedures (i.e. develop the total system).	Programs and procedures, test results
Implementation	To initiate activities for testing, training, system conversion and installation.	Operational system and user manuals
Operation	To ensure that the system meets operational requirements and is smoothly integrated into operational environment.	Evaluation report

The employment of this development life cycle usually follows the forms shown in Exhibit 11. This figure shows the relationship of phases, not the relative duration of each phase.

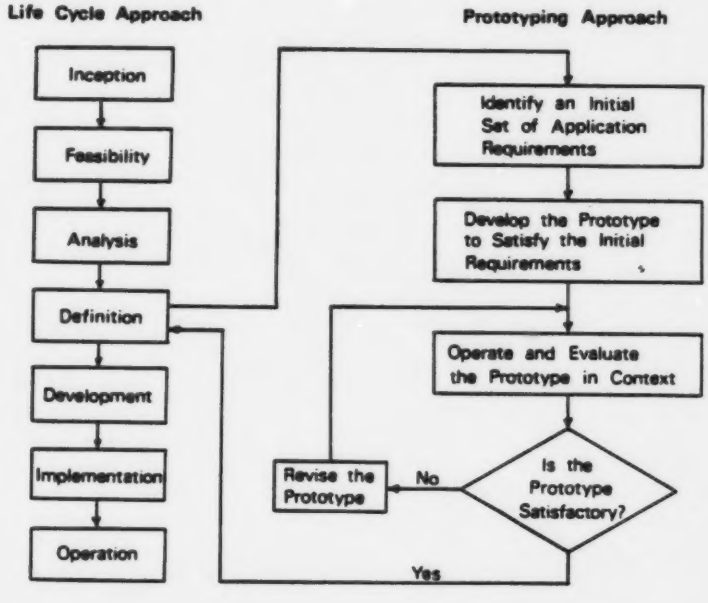
Exhibit 11: Traditional Systems Development Life Cycle



prototypes was the approach that was used in this project to ensure that the computer systems were tailored to the requirements, constraints and capabilities of the custom transit operators.

The prototype period begins once a function has been developed and tested for the new system. The software is installed as operational, but careful attention is provided to the users of the system and their changing requirements.

Exhibit 12: The Prototyping Approach Used



Even the best requirements specifications are unlikely to remain unchanged once the system is installed and operating. The basic reason for using a prototype is that it is easier to make changes to a system when it it not fully installed. The duration of a prototype depends on many factors, including application complexity and number of changes identified.

The use of a prototype also resulted in the following benefits:

Prototyping is real. A systems prototype provides the user with a tangible means of comprehending and evaluating the proposed system and elicits more meaningful feedback from users in terms of their needs and requirements. Users are extremely capable of criticizing an existing system but are not too good at articulating or anticipating their needs.

It provides a common base line. Prototyping represents a common reference point for both users and developers to identify potential

After a period of testing and evaluation, one system was to be selected (or developed from the components of the tested systems) for further expansion to the other six custom transit operators in the Vancouver area. At the same time, an attempt was to be made to 'network' or provide a means of coordination and communication between the operators. The selected system would also be made available for distribution to other interested transit agencies in Canada.

Although it was proposed that two separate and different types of computer scheduling systems be obtained, it was anticipated that one of the systems would be integrated with the existing custom transit software that had been developed by BC Transit for the operator in the City of Victoria. This system provided computer assistance in the client registration and trip reservation functions of custom transit.

The general project methodology included the sequencing of activities and decisions leading to the definition, development, and implementation of computerized scheduling systems for custom transit services.

A cyclical process was used to tailor the computer systems in relation to the requirements, constraints and capabilities of the transit operators.

Selecting the Prototypes

In 1984 and 1985, BC Transit conducted an international search for computerized management and scheduling systems for special transit.

As a part of this investigation, BC Transit sent out a "Request for Expressions of Interest and Statements of Qualification" to various systems suppliers in 1984. Following a review of the responses and an assessment of the requirements of the custom transit operators, it was decided to implement a decentralized system oriented towards the application of microcomputers by individual operators in the region.

Respondents to the previous Request for Qualifications who were able to provide a decentralized microcomputer-based scheduling system were invited to submit proposals for the supply and installation of either:

1. **A Computer-Aided Scheduling system.** The computer-aided system was intended to be a turnkey system which accommodated the client registration, trip reservation, trip scheduling and dispatching requirements of custom transit.
2. **A Computerized Scheduling System.** The computerized scheduling system would serve as an addition to the existing computerized client registration/trip reservation system. The computerized scheduling system was intended to provide only the scheduling function and was intended to work in conjunction with the client registration/trip reservation system that already existed in Victoria.

6. TECHNOLOGY

It is clear that the computer can have an enormous impact on both the quality and speed of information flows within the management and operation of a custom transit office. And it should be possible to translate this improved office efficiency into improved productivity on the road.

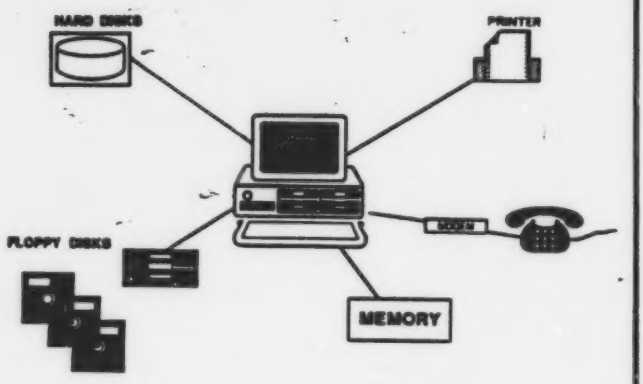
Computer assistance should enable the custom transit office to attain the following objectives: the elimination of redundant and unnecessary tasks such as copying of information; better utilization of human resources at tasks that require judgment, initiative and analysis; faster, better decision-making; and better communications with the clients.

The extent to which the computer can aid in the scheduling function is a more complicated issue. But it is in this area where the greatest benefits are anticipated. Matching the supply of available vehicles with the demand for trips and making the most effective use of limited resources are the challenges faced daily by managers of special transit services.

In reviewing the application of computers to special transit services, it was deemed to be most feasible to provide a microcomputer to each independent operator in the Vancouver Region. It was also concluded from the analysis that additional benefits could be achieved by investing in equipment to facilitate communications between the separate operators.

Based on the conclusions resulting from the feasibility analysis and on the requirements of the Transportation Development Centre for systems that could be easily transportable to other special transit operations in Canada, the Steering Committee decided that the software should be developed for IBM PC microcomputers (and compatible units).

Exhibit 13: Single-User Microcomputer



Computers use floppy or hard disks to preserve data. An important limitation of single-user systems is that files on a floppy or hard disk can't be used by more than one person at a time.

In fact, transferring files between single-user systems is rather difficult. Some sort of connection between two machines might allow files to be transferred electronically (such as with a modem). But the transfer is normally slow and both machines are tied up while the transfer takes place.

Multi-tasking allows a user to do several tasks at once but this is still uncommon in single-user systems. With multi-tasking, the CPU of the machine divides its time between several tasks -- but still only for one user.

In fact, any peripheral, such as a printer or modem can only be used by any one system at a time -- a single-user system is dedicated to that user and there is no sharing of peripherals.

These are several of the limitation with single-user systems. The limitations can always be circumvented, as long as some compromises can be made. With multi-user and LAN systems, however, the majority of these difficulties disappear completely. With this increase in efficiency, however, comes an increase in complexity.

Multi-User Microcomputer Systems

Multi-user systems evolved from the large mainframe computers, which were designed so that many users could plug in at the same time and do their work simultaneously. Exhibit 14 on the following page shows a schematic of a typical multi-user machine.

Let's look at the multi-user system from the user's perspective -- the terminal. The terminal consists of a video screen and a keyboard. It does not have a memory or storage space so that it can't be used to perform work outside the larger system. It is called a 'dumb' terminal.

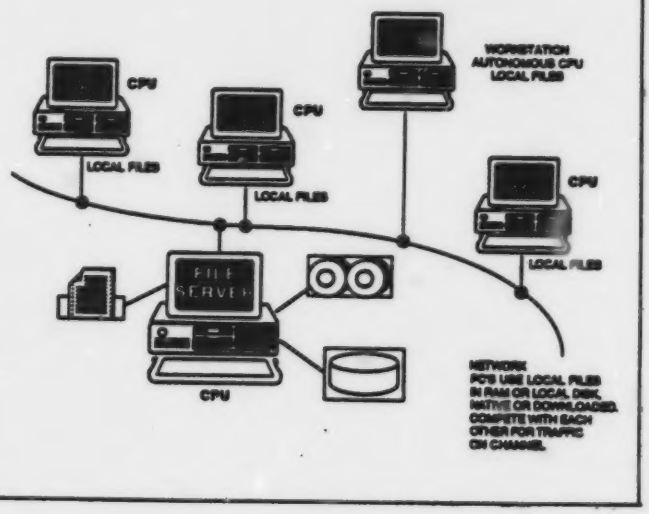
All multi-user systems share common characteristics. All the users that are simultaneously logged onto the system share its power, and the CPU attends to the tasks submitted by users that are logged on in a round-robin fashion. This technique is called time-sharing (or multiplexing).

This is the advantage of the LAN over the multi-user system -- a task is performed by a dedicated machine. Work on other machines does not slow the task down. In a multi-user environment, the central CPU would have to divide its attention between the commands of the various users.

When the power of all the workstations in a LAN is considered it is often greater than that of many minicomputers. It also allows for the use of many common commercially-available software packages since it uses the same operating system as single-user systems.

Operating systems for local area networks, however, that contain the functionality of a multi-user system are only a recent development. These permit the sharing of data over the LAN, with protective features such as file locking and record locking, and the transferring of files from one workstation to another.

Exhibit 15: A Local Area Network



There are also some drawbacks to LAN systems. Multi-user systems, including the software and hardware, are well-developed and usually purchased from one manufacturer.

LANs, however, tend to be a do-it-yourself affair. You buy the work-stations from one vendor, the LAN hardware from another, and perhaps the LAN software from someplace else. There are some LAN vendors, such as the IBM Corporation, that provide and service whole systems. Many technical and economic benefits, however, can be gained by going at it on your own.

For small systems, the LAN can be a productive investment. It is the natural evolution to increase the versatility and usefulness of the personal computers that sit on so many desks today.

Networking vs Multi-User Systems

A local area network's primary strength compared to a multi-user system of comparable size is the distributed processing environment it provides. A multi-user system, on the other hand, allocates computing resources to users via a shared-logic, or centralized, central processing unit (CPU). A distributed environment enhances the efficiency with which a user can run certain applications. It also makes more difficult the provision of certain added efficiencies that a centralized processor can supply.

APPLICATIONS SOFTWARE APPROACHES

Another major consideration in the selection of software packages for the demonstration project was the approach to the scheduling function. The computer can be used to display information to assist in the decision process (computer-aided system), or it can function with little or no human decision-making assistance or intervention (computerized system).

Since there was a lack of proven success with computerized systems (although many systems have attempted to optimize the insertion of trips into existing 'master' schedules), it was decided to stay with a computer-aided approach. If, at some future time, more automated scheduling features became practical, then these could be added to the system

Once the computer-aided approach was decided on, it was necessary to define the type of computer assistance that would be provided. Computer assistance in the scheduling task can be through the use of algorithms, heuristic techniques, or graphical aids.

Since manual scheduling systems are usually either time or spatially-oriented, it was decided to test both approaches on the computer by using: (1) a tabular (time-oriented) approach, and (2) a graphical (spatially-oriented) approach.

A Tabular Approach to Scheduling

The time-oriented system is perhaps more common with special transit operators in Canada. In this system, large tables or boards are usually prepared (one for each day) with time in half-hour segments down the side and vehicles across the top. Each cell of the table contains a trip request and each column all trip assignments for one vehicle for the day.

The board system provides excellent time information; each vehicle run is arranged by time, giving the scheduler a view of promised pickup and insertion windows. This system, however, assumes the ability of the scheduler to mentally maintain a service area map with vehicle locations and trip requests. Even an experienced scheduler soon reaches a saturation point in the number of vehicle runs that can be handled.

Therefore, it was decided that one of the computer demonstration tests should look at this approach to presenting scheduling information -- but with the possibility of providing more locational information through the use and display of zone codes to define location, as well as indications of the vehicles status with respect to capacity.

multi-user microcomputer system with two or more terminals, using a Xenix operating system. The function of the original system was to provide computer-assisted aids to register clients and to reserve trips. Part of the system capabilities included housekeeping activities such as printing mailing labels. Overall, the objective of the system was to provide computer assistance to make the transit operator more efficient.

After adding the multi-user capabilities, the system was then enhanced to provide some improved scheduling features, adding full schedule information to the software through the display of a scheduling screen which showed vehicles and vehicle assignments for each day and time period. Easy keyboard strokes allowed managers to check on vehicle status and instantly assign passenger trips.

The major functions in the system can be divided into two categories: client registration/trip reservation and operations monitoring. Although the actual scheduling of trips is a manual procedure, the system assists in storing, retrieving and displaying client registration/trip reservation information (e.g. client information, trip requests, daily trip sheets) used to assist the scheduling process. The operations monitoring function assists in analyzing daily trip logs and producing vehicle statistical summaries and performance reports. The following section provides a brief description of the major system functions:

Client Registration. The client master file contains all of the pertinent personal information on each registrant including a registration number that is automatically generated by the computer. There are currently 2,800 persons registered to use the service provided by the Western Society with 25-50 new clients being added each month. The computer provides rapid access to the registration data by either client number or name. It also insures that everyone who uses the system has been registered. Information can be added, deleted or changed easily.

Trip Reservation. The system provides several trip reservation functions: (1) subscription trip requests, (2) advance booking trip requests, (3) cancel, change or query trip, and (4) display trips currently booked for a client. The trip reservation system is designed to require minimum user input of information. In the trip request procedure, the user enters the client's registrant number or last name which produces a split screen display of registrant and trip information. The computer prompts whether the trip is outgoing or incoming. If the trip is outgoing, data from the registration file, (e.g. name, origin address) is used to supplement user input. On incoming trips, data from the previous trip is used (e.g. pickup and dropoff addresses). The use of a trip expiry date allows input of both subscription and reservation type trips. The system can be purged of all trips that have expired. As well, the start and stop dates of a subscription trip can be input in order to temporarily suspend a trip. This is useful when a trip is cancelled for one or two weeks due to illness or vacation.

Report Generation. There are several reports that can be produced. On a daily basis, the Delete Subscriber and Daily Trip reports are produced. The Daily Trip Report contains the information necessary for the drivers to proceed with their daily run. Daily, monthly and year-to-date reports on vehicle statistics (ridership, hours, kilometers, etc.) are also available. Several other reports, providing a listing of disability and zone codes and their descriptions and common addresses, are also available. Another report, Client Statistics, groups clients by disability and zone as well as providing a breakdown by trip type. The system is also capable of printing client mailing labels by either zone or registration number.

Operations Monitoring. During and at the end of each day, the trip file is updated to reflect what actually takes place on the road. After information on fuel usage, distance travelled and shift time is added, the computer has all the necessary information to produce the monthly statistics report. Vehicle and system information is available by day, month and year-to-date. The statistical reports provide information for compiling vehicle schedules and for planning and monitoring purposes.

A monthly report on the daily productivity of each vehicle provides a comparison of vehicle utilization. The supervisor is able to adjust schedules based on this information to ensure that all vehicles are well utilized. A comparison of vehicle kilometers and passengers carried provides the drivers with an indication of workloads. The breakdown of ridership by vehicle by day assists in the allocation of trips to vehicles. A report on the fuel efficiency of each vehicle highlights major deviations and possible mechanical problems.

Exhibit 18: DART Manager Plus Computer

Software. DART Manager Plus is written in a standard business application language, RM-COBOL. Other computers are capable of running the custom transit program with very little or no modifications. The application program must be recompiled on the new computer.

IBM PC Environment. DART Manager Plus runs on any IBM PC, PC/XT, PC/AT, or 100-percent compatible running under XENIX or DOS 3.1 with 384KB to 640KB of RAM and one floppy drive and a hard disk. The system can keep vehicle schedules for up to 64 vehicles.

Scheduling Module. The scheduling subsystem displays the primary information including such key data as pickup and delivery sequence, vehicle assigned, and location of vehicle, for all requests and vehicles that are to be scheduled in the current time frame. The scheduler makes decisions based on the spatial and time information provided by either the textual display or the graphical display. The secondary information including such data as number of passengers and vehicle capacity is important, but the scheduler does not refer to these data for all scheduling decisions, leaving it to the computer to keep track of.

The location of the pickup and delivery stops, promised pickup and delivery time, and the passenger's use of a wheelchair or not is provided by the order taking function. The scheduling subsystem automatically calculates and updates the estimated pick-up and delivery stop time for all requests and checks vehicle capacity.

Exhibit 19: DART Manager Graphics Screens

A static scheduling procedure may be used when all the requests for service are known at least a day in advance -- then a 'fast' function can be used to schedule the trips. If only a few requests are known in advance, they are easily handled one at a time either with the keyboard

The MIS programs are written in dBase III so that (1) they can be easily adapted to an individual site's requirements, and (2) individual ad hoc reports can be easily obtained. The standard reports produced by the MIS programs include: a daily operational summary, a monthly operational summary and a monthly operator's invoice (for billing a funding agency). The information used in producing the reports is derived from the booking, scheduling and dispatching functions and corrected, where necessary, from the individual driver trip logs.

Software. DART Manager Graphics has been written in Microsoft Pascal, but using a number of tools and procedures from the Turbo Pascal toolkit. Pascal is a common language with a large following among programmers since Turbo Pascal became so readily available for microcomputers.

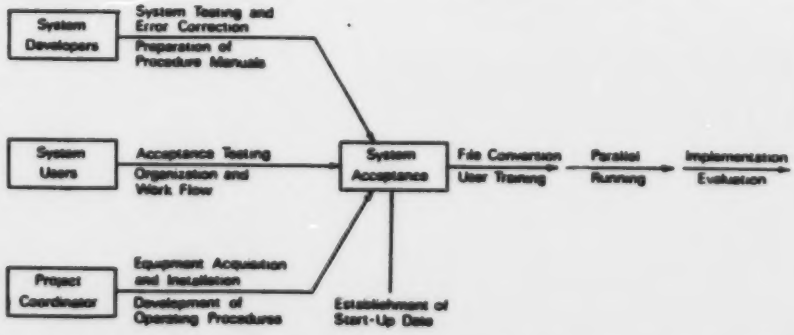
IBM PC Environment. DART Manager Graphics runs on any IBM PC, PC/XT, PC/AT, or 100-percent compatible running under DOS 3.1 with 640KB of RAM and one floppy drive and a hard disk. It can also be used with a local area network using the Novell software and 3-Com hardware. The initial capacity limitation of the system was about 500 trips per day.

6. IMPLEMENTATION

Systems implementation includes all activities that occur during the actual installation of the systems and generally involves new equipment, work methods, programs, and user responsibilities. The task of systems implementation is generally a major undertaking, resulting in a requirement for some implementation planning.

A logical starting point for this type of planning involves knowledge of the following areas: personnel needs, programming, documentation, controls, equipment, physical requirements and conversion activities. An understanding of these areas establishes the specific tasks that must be undertaken and the relationship among them. This background permits detailed planning of the implementation process.

Exhibit 21: A Systems Implementation Process



Software. Well-designed software for users requires a sensitivity to users' lack of technical skills and language as well as inexperience with computer procedures. End users cannot follow computer procedures described in computer jargon. In every case, the systems and procedures had to be kept very simple and described in plain English. Menu items on the screen had to be especially clear. The users, in fact, often requested changes in the description of menu items or function keys to make the system more understandable. Easy cursor movements (using the cursor keys to move around the screen), easily-understandable menu choices and the use of codes and default values were deemed to be important to ease the burden of entering data into the system. The codes were, naturally, defined by the users so that they would be more easily remembered.

Environment. When technology is not designed for humans and the work space is not designed to support their use of technology, an organization can experience more job dissatisfaction -- in essence, lower productivity and neglect of the technology, or possibly even sabotage. Users who feel that the emphasis is on the technology and not on them can respond negatively. Therefore, considerations were provided for: the selection of the proper furniture, soundproofing with screens to separate work areas, proper ventilation to keep the equipment and operators from over-heating. New furniture, screens and air conditioners were provided as requested by the operators in order that the proper environment would be provided and to show that not all the emphasis was on the technology.

Marketing Technology to End-Users

Marketing to end users does not refer to selling them a system. Rather, it is selling users on the inevitable change created by the implementation of the new technology.

If a new system can be successfully sold to the end users, they are more likely to become partners in -- not adversaries to -- the change. By becoming partners in the change, users feel more like owners of the system and are more motivated to use it effectively.

An example of what was deemed a successful marketing strategy was the demonstration of the candidate computer systems to all interested operators prior to the selection of which system to implement. Before systems were purchased, a meeting was held with the operators. At the meeting, the systems were demonstrated and everyone was invited to test them. The operators were then asked for their opinions and these were incorporated into the evaluation process.

This 'marketing' technique cost very little. Yet it increased the sense of involvement of the special service operators in the decision process; and, at the same time, increased the confidence of the decision-makers in the choice of systems to demonstrate.

can prevent the development of a negative attitude toward the computer and can create a positive environment. This is expecially beneficial since, in most cases, this was the user's first exposure to computers

The other approaches did not provide the vital hands-on experience as a part of the instruction that was deemed to be necessary. The third method, programmed learning, was deemed to be a cost-effective method for training potential users in other areas of the country and it was encouraged with an interactive computer-based tutorial program.

Follow-Up Training. Several follow-up training services were provided to end users. First, if users had any problems with the system, they were told who to call to resolve the problem quickly. Second, each user was periodically contacted, usually in person, to see how the system was working and to see if there were any problems that need resolving.

This is a step that was continuously under-estimated in this project. The amount of time spent in follow-up training was considerable. For the first six months after implementation, a knowledgeable person had to visit the site probably every second day for one or two hours. Even well after the system had been operating, a visit once a week was necessary. Probably more time could have been spent with the users with worthwhile results -- monitoring the operational changes and suggesting improvements.

End-user training is generally conceded to be difficult because it is about the only training that might be considered involuntary. Not everyone wants to be a user of technology. In our case, however, the end-users were enthusiastic and made the training an enjoyable experience.

UNDERTAKING THE SYSTEMS IMPLEMENTATION

Equipment Acquisition and Installation

Equipment acquisition and installation requires special attention because one simple mistake or misunderstanding on the part of the vendor or the project team can delay startup and increase installation costs. For example, a problem with the bitpad connection took considerable time to resolve because the manufacturer had delivered the wrong connection (incorrect pin assignments) which was not immediately recognized.

Several concerns are important with hardware acquisition and installation. Is the order complete and according to specifications; has the vendor tested the equipment prior to delivery and are all the connections working? This is especially important if a local area network or a multi-user system is being implemented. On this project, the vendor was made responsible for making sure that the equipment was working properly prior to delivery so that the project team could be assured that any problems could be attributed to the software and not the hardware.

Installation of the computers into the offices of the custom transit operators required additional equipment, including: a separate electrical outlet for the equipment, air conditioning, computer tables, and cabinets to store the floppy disks.

An aspect of systems installation that should not be overlooked is the purchase of computer supplies; that is, paper sheets, tapes, disks, cards, log books, printer ribbons and cleaning equipment. Anticipating probable use rates and the initial reorder levels and quantities was difficult but improved through experience.

Operating Procedure Development

Operating procedures control the operation of the computer system in the custom transit office (e.g. hardware, libraries, care of disks, error logging, backing up, hardware maintenance). Although these procedures cannot replace well-designed systems, they are essential to smooth operations. Special attention was given to infrequent and uncommon operations, particularly system recovery and supply reordering.

Operators were provided with instructions on how to care for equipment and supplies and were also requested to maintain a computer log in order to provide a dairy of their operating procedures and problems. This was particularly useful to the system developers in determining problems.

Systems Testing and Acceptance

The systems testing and acceptance process was relatively informal since it was a continuing ongoing process during the life of the demonstration project. As mentioned previously, a prototype development approach was used. The operators were provided with working systems and as they became familiar with particular functions of the systems, they were tested and accepted or requests for modifications were made. These requests for modifications ranged from the relatively simple (change in name for a menu item) to the more complex (moving between particular functions without having to go through the main menu).

Also, as the developers worked with the users and learned more about the way that they wished to perform various operations, additional changes were suggested by the developers prior to final testing and acceptance.

If the project team felt that the modifications were necessary, the developer and the project team would jointly determine whether requested modifications were a part of the initial contract (i.e. a result of a fault in the original design) or whether a new contract would be required (i.e. an enhancement that was not originally envisaged). Sometimes, a small contract would be awarded to effect the changes. The development of DART Manager Plus, for example, required three main contracts and a number of smaller contracts before the final system was accepted.

The ongoing systems testing and acceptance during the development process was finally completed when it was deemed by the operators and the project team that the systems were 'working' satisfactorily with no 'bugs' or system interrupts during normal operations.

WORKING WITH THE NEW SYSTEMS

Once the initial programs had been written and tested, considerable work remained to integrate all the components into a system. Even though the programs were being systems tested, there was no way of knowing that the system would really operate correctly without duplicating the actual flow of work with all its exceptions and timing considerations.

This was a learning process for the developers who often found that the users liked to do things differently than originally envisaged. It was also a learning process for the users who found that sometimes a change in procedures was warranted. It was felt that the best way to ensure that the new systems would work satisfactorily without service disruptions was to conduct parallel operations for a period of time.

manual systems and begin relying completely on the computer system. The start-up dates therefore moved from June 1986 to January 1987 to March 1987 for DART Manager Plus, and from September 1986 to November 1986 to March 1987 for DART Manager Graphics.

Post-Implementation Activities

Post-implementation activities included considerable support for the users: answering questions with respect to specific functions of the programs and computers, solving problems like hard disk crashes, faulty keyboards, unexpected data corruption, and so forth.

Although only two computers were used in the demonstration project -- one for each system -- about three hard disks had to be replaced. Another difficult problem was the acquisition of a reliable tape backup system. The backup systems that were obtained seemed to continually have faulty or unreliable tape cartridges.

Aside from the hardware problems, the project team spent a fair amount of time with software and operational problems -- answering questions, demonstrating functions, and so forth.

The Final Operational Systems

In March 1987, after about a two-year development process, both computer systems were deemed to be successfully operational.

A successful final operational system is easily recognizable: it is used with pride and enthusiasm; users highly regard it and never blame it for mistakes. Feedback to the developers was frequent and positive. Systems are sophisticated tools, and users choose how much they will learn about the system according to how much of an advantage this knowledge will provide. Unless informed about the system's capabilities, users will pay it scant attention; if promised more than it can deliver, they will resent it.

Systems that are unresponsive to user requirements or unable to satisfy the developer's promises will fail from lack of use. Even the most technically elegant system is a failure if it is not used enough to produce benefits sufficient to offset its cost. The unused system will exist in an environment in which the developer and the user did not cooperate.

Both DART Manager Plus at the Western Society for Senior Citizens' Services and DART Manager Graphics at the handyDART North Shore service are used by the operators with a degree of pride -- partly because of their own efforts in defining the type of computer system that they wanted the developers to build for them.

A Chronology of Significant Events

May 1, 1985	Request for Proposals for supply of computer systems issued to short-list of seven suppliers.
Aug 2, 1985	Contracts awarded to AIM Software for multi-user version of DART Manager and SRI International for a systems analysis of Pacific Transit's operations.
Sept 18, 1985	Purchased hardware for DART Manager Plus.
Oct 7, 1985	Installation of multi-user version of DART Manager at Western Society.
Nov 6, 1985	Contract awarded to SRI International for DART Manager Graphics.
Nov 19, 1985	File creation/staff training for multi-user DART Manager.
Nov 28, 1985	Purchased hardware for DART Graphics.
Dec 2, 1985	Begin operations at Western Society with multi-user version of DART Manager.
Jan 7, 1986	Contract awarded to AIM Software for DART Manager enhancements (Plus).
Feb 19, 1986	Order entry module of DART Graphics installed at Pacific Transit Cooperative.
Mar 11, 1986	File creation and staff training for DART Manager Graphics at Pacific Transit.
Apr 15, 1986	Debugging of both DART Manager Plus and Graphics.
May 06, 1986	Scheduling module of DART Manager Graphics implemented at Pacific Transit.
May 22, 1986	Installation of DART Manager Plus at the Western Society.
June 19, 1986	DART Manager Graphics moved to new location at North Shore HandyDart.
June 30, 1986	File creation and staff training for staff at new location.
July 28, 1986	Operations planned for North Shore but are delayed due to bugs in program.
Sept 10, 1986	Contract awarded to AIM Software for additional modifications to DART Manager Plus.
Nov 4, 1986	A new version of DART Graphics is installed.
Nov 14, 1986	Modifications for DART Plus completed.
Nov 16, 1986	Full operations for DART Graphics are planned but delayed due to staff holidays.
Dec 3, 1986	Installation of modified DART Manager Plus.
Jan 6, 1987	Operations begin with DART Manager Plus but are delayed due to system crashes and data corruption.
Jan 23, 1987	New version of DART Manager Graphics is installed and operations are planned to begin but are delayed due to contract negotiations.
Mar 9, 1987	**Full operations with DART Manager Plus at Western Society and DART Manager Graphics at North Shore.**
May 1, 1987	Completion of user manuals for distribution to other operators in Canada.

7. EVALUATION

The project approach was to develop and test two different computer software packages for special transit service operators. Consequently, there were several alternatives that required evaluation. The alternatives were evaluated to determine the best alternative for expansion to the other operators in the Vancouver area and for coordination between operators. In addition, the alternatives were evaluated to determine the overall benefits and costs of applying computers to special transit services. Finally, rules or guidelines were developed to guide the application of the computer systems by other operators in Canada.

A decision model was therefore required to analyze, evaluate, and communicate the many numeric and subjective variables that were part of the decision-making process. A decision model is a method of evaluating a group of alternatives with the goal of choosing one or more for action. The proposed decision model incorporates several weighted criteria.

A decision model helps to organize information about the alternatives, the criteria to be measured, and personal values of the decision-makers. This information is then analyzed so that the best alternative can be identified according to how completely it meets the requirements of the evaluation criteria. The decision-modeling process consists of two main activities: defining and evaluating.

The 'definition' activity covers several tasks including: selecting the alternatives; defining the criteria, the important factors used to evaluate the alternatives; and the performance measures, for measuring how well each alternative performs with respect to each criteria.

Defining the Alternatives

The first step in building the decision model is to list what choices are available for reaching the goal. In this particular case, the goal is to find the most suitable computerized scheduling/dispatching system for expansion to other special transit service operators. The possible choices -- or alternatives -- for reaching the goal are:

- **Manual Systems**, the baseline alternative signifying the existing or 'before' situation in which no computer system is used;
- **Dart Manager Plus**, the single- or multi-user version of the enhanced Victoria computer system using a textual or tabular display of time-oriented information to assist with the scheduling process;
- **Dart Manager Graphics**, the single-user or local area network version of the SRI graphical display system for computer-aided scheduling and dispatching, using the computer as an information display device to aid in the decision process.

The 'Manual Systems' alternative was considered to be the 'before' situation occurring in fiscal year 1984/85 -- April 1, 1984 to March 31, 1985. The 'Dart Manager Plus' and 'Dart Manager Graphics' alternatives were the 'after' situation occurring in fiscal year 1986/87. As well, the 'during' situation, fiscal year 1985/86, is reported for comparison.

Selecting the Criteria

The criteria that were used in this model were developed from three different perspectives: the transit operator, the overall transit service, and the funding agency. The categories of criteria from each of the perspectives in turn include: effectiveness, efficiency, and economy:

- **Effectiveness**, to measure the (non-quantifiable) impacts of the alternatives on the computer system users in terms of factors such as system reliability, ease of implementation, ease of use, level of operator sophistication required, employee morale, reductions in workload, reduced stress and tension, assistance required, etc.
- **Efficiency**, to measure the quantifiable impact of the alternatives in non-monetary terms on the overall operating efficiency of the transit service in terms of passengers per hour, kilometers per hour, deadhead kilometrage, passengers per vehicle, trip requests per office staff, and other suitable transit service performance measurements.
- **Economy**, to measure the quantifiable impact of the alternatives in terms of an overall cost-benefit effect on the transit service funding agency. Quantifiable costs would include the cost of the computer system and quantifiable benefits would include the additional passenger trips that could be carried for the same budget.

The version of DART Manager Plus which uses the Xenix operating system generates additional implementation and administrative requirements. The Xenix operating system is not really one that can be used by most managers of special transit systems. Thus, additional outside help would be required to install the system. DART Manager Graphics, on the other hand, operates under MS-DOS which is a more user-friendly system. The local area network would require additional help but this should be supplied by the vendor of the network.

Since DART Manager Graphics uses a common database management program, dBase III, to produce management information reports, it is considered to be more flexible and easier to use to customize and produce management reports. Without a Cobol programmer who knows the system, it would be difficult to change the reports for DART Manager Plus.

System Response Time. Tests were conducted to measure the performance of the systems with respect to this criterion. The number of keystrokes required and the time required to complete various functions on each computer system were measured. The results and the tabulations are presented in Appendix A of this report. This comparison indicates that DART Manager Graphics requires fewer keystrokes and generally less time to accomplish typical special transit functions and should facilitate quicker trip booking and scheduling.

In comparing response times to the manual system, no clear conclusions can be drawn. The reason is that, with most manual systems, incomplete information is often taken (the rest of the information for the trip may be mentally stored by the call-takers and schedulers). The response time in recording a trip request may be faster manually but the information is incomplete. Certainly, the computer systems are almost as fast if the operator has good keyboard skills.

Improved Information. The computer systems most definitely increased the volume of information available, speeded up the retrieval of information, improved the accuracy of information, and helped to combine old information in new ways. This helps most in planning and decision-making by reducing mistakes and increasing the reliability of the information. Although improved information would appear to be one of the most obvious benefits of computers, it is more difficult to assess because it is less tangible.

Improved Morale. Although this factor is even more difficult to define, it is believed to be worth mentioning. The attention that is drawn to the operators when a new computer system is being implemented seems to increase the morale of the office staff considerably -- in spite of the stress that naturally results from a re-definition of work from the manual system to the computer system. Everyone seems to realize that computer skills are becoming an advantage in the work force today.

Exhibit 22: Cost of Hardware for DART Manager Plus

Basic System Configuration		
IBM PC/AT with Memory Upgrade to 640 Kb; 1.2 Mb Floppy Disk Drive and 20 Mb Hard Disk Drive; Monochrome Adapter/Display	$ 8,415	
Streaming Tape Cartridge Backup System	1,608	
150-Cps Dot Matrix Printer	747	
Power Regulator	590	
IBM Xenix Operating System	369	
Total for Basic System Configuration		**$ 11,729**
Additional Workstations		
Wyse Terminal with Swivel Screen, Detachable Keyboard, Multi-Terminal Emulation	$ 859	
Total for Each Additional Workstation		**$ 859**

Exhibit 23: Hardware Costs for DART Manager Graphics

Basic System Configuration (without Graphics)		
IBM PC/AT with Memory Upgrade to 640 Kb; 1.2 Mb Floppy Disk Drive and 60 Mb Hard Disk Drive; Monochrome Adapter/Display	$ 8,444	
Streaming Tape Cartridge Backup System	1,608	
150-Cps Dot Matrix Printer	747	
Power Regulator	590	
IBM DOS 3.1 Operating System	65	
Total for Basic System Configuration (without Graphics)		**$ 11,454**
Basic System Configuration (with Graphics)		
Basic System Configuration	$11,454	
IBM Professional Graphics Controller / Display	5,575	
Bitpad Electronic Tablet and Mouse	1,325	
Total for Basic System Configuration (with Graphics)		**$ 18,354**
Additional Workstations		
IBM PC/XT with Memory Upgrade to 640 Kb; 2-360 Kb Floppy Disk Drives; Monochrome Monitor and Adapter	$ 4,218	
IBM PC Network Adapter, Translator, Cable and Software	1,632	
Total for Each Additional Workstation		**$ 5,850**

DART Manager Graphics system. Since the overall ridership in the region increased by 20.8% in the same period, from 382,473 to 462,186 annual trips, it is not possible to attribute these increases to the computers.

Based on this service ridership, this operating cost savings translates roughly into an annual benefit of $39,300 for the DART Manager Plus system and $26,000 for the DART Manager Graphics installation.

To see if this saving is due to an increase in productivity or to lower wage rates, we would have to look at the operating cost per hour. The operating cost per hour for each installation (again in constant dollars) is shown below:

Operator	System	Before 84/85	During 85/86	After 86/87
Western Society	Plus	$22.49	$23.51	$24.19
North Shore	Graphics	$22.37	$22.70	$22.05

The operating cost per hour (in constant dollars) increased 7.6% for the Plus installation and decreased 1.5% for the Graphics installation. Therefore, the benefits for the Plus system are probably under estimated and for the Graphics system are probably over estimated.

Cost Benefit Analysis

The purpose of this criterion is to provide an indication of the possible return on the investment in a computer system. For illustrative purposes, the preceding benefits (operating cost improvement) and costs (acquisition costs of the computer) were used for the evaluation:

Operator	System	Initial Cost	Annual Benefit	Payback Period
Western Society	Plus	$13,447	$39,300	4 mos
North Shore	Graphics	$18,354	$26,000	8 mos

As shown, an investment in a computer-aided scheduling system (assuming that there are no large system development or software customization costs) should result in savings that would more than pay for the acquisition costs of the computer within one year.

This analysis shows that, with the low cost of small personal computers, the resulting benefits do not have to be very large to make it worthwhile to computerize an operation (with public domain software).

8. CONCLUSIONS

In March 1985, in order to foster the development of technology to improve transportation services for elderly and disabled persons, the Transportation Development Centre of Transport Canada and British Columbia Transit initiated a jointly-sponsored, two-year, scheduling/ brokerage demonstration project in Vancouver.

Computerized scheduling/brokerage systems are designed to coordinate and stimulate increased transportation efficiency by: (1) identifying specific travel demands, (2) selecting services to meet those demands, and (3) matching the demands with the service in cost-effective manner.

The specific objective of the demonstration project was to improve the quality and cost-effectiveness of transit services for disabled persons through the selection, implementation and demonstration of computerized scheduling/brokerage systems, with particular emphasis on the best application of microcomputer technology to the personalized form of transportation offered by special services.

Emphasis was placed on the application of technology to an existing organizational and operation structure. Special transit services are provided by small community-based operators. It was anticipated that coordination and increased efficiency would result by providing each operator with a microcomputer with appropriate software and then connecting the various computers with an electronic network so that they could better communicate with each other.

To develop and test the computer systems, several systems were acquired and placed in an operational environment where the potential users would

For office staff -- the call-takers, dispatchers and schedulers -- paperwork is greatly reduced with computers. Mistakes from hand-written entries and notes are reduced. It is easier to train new staff with a computer system in place. Drivers don't have to copy out their daily run sheets. Accuracy and reliability of information is improved.

Lead time requirements for advance bookings are reduced since schedules can be developed in a shorter time. For example, North Shore handy-DART previously required 48 hours advance notice to book a trip. Trip bookings are now accepted up to 3 p.m. on the day before the trip (i.e. 16 to 26 hours advance notice). Scheduling of next day's trips is accomplished between 3 and 5 p.m. and driver run sheets are printed as soon as the schedules are completed.

Once a computer system is in place, some operators have also found that they can easily add more service with no additional office staff requirements. One of the operators in Vancouver, for example, added two additional vans with no additional office staff.

What it Means to Clients of the Service

The introduction of a computer system can reduce the average telephone dwell time for the trip reservation process -- improving the quality of service for the user as well as increasing the productivity of the office staff. Clients' requests for trip status and other information are also handled more quickly and easily. For example, the time to book and schedule a trip manually was measured at 3.9 minutes; whereas the same process using the computer was measured at 1.4 minutes using DART Manager Graphics and 2.5 minutes using DART Manager Plus.

Service quality is also improved as measured by: (1) the difference in times confirmed to clients and actual pickup and dropoff times, (2) the number of scheduling errors or omissions, and (3) the percentage of unmet trip requests. In short, a computer system can help the office staff provide a better, more responsive service to their clientele -- both over the phone and on the road.

What About the Administrative Agency

The implementation of a computer system should improve the accuracy and timeliness of management information reports. Reports are naturally easier to produce with the assistance of a computer to retrieve and tabulate the raw data. The raw data, once entered into the computer, can be tabulated and presented in a variety of forms to make it easier to monitor and manage the service in a cost-effective manner. Better reporting ensures better accountability for the funds expended on the special service.

a unique method of scheduling and dispatching, it must be left up to potential users to decide which system is best for them.

3) The development and testing of computer systems takes considerably longer than anticipated. The process also requires considerably more support on behalf of technical and project management staff than anticipated.

4) User involvement in the selection (or development and testing) of computer systems is absolutely essential and the interest and involvement of the users in Vancouver was a key reason for the success of the systems.

5) Automatic trip scheduling 'suggestion' techniques would greatly enhance the effectiveness of the computer systems since these would allow the operators to provide immediate information related to a trip at the time that the client requests the service.

RECOMMENDATIONS

More Support and Enhancements

Finally, the following recommendations have resulted from the demonstration project in Vancouver:

1) BC Transit (and possibly other Provincial transportation agencies) should establish an information support centre to provide ongoing advice and support for special transit service operators in their own jurisdictions who decide to implement computer scheduling systems.

2) BC Transit should establish a regional communications network so that operators with computers can more easily exchange information related to trip requests that pass beyond local operators' service areas.

3) If the software packages find wide application throughout Canada, Transport Canada should investigate potential improvements to the software, such as heuristics for automatic trip assignment suggestions.

4) If the software packages find wide application throughout Canada, the operators should form a user group that could act as an advice and support centre for themselves.

5) The DART Manager Graphics package should be enhanced to include an automatic trip scheduling technique so that operators can provide immediate confirmation of trip requests to clients.

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APPENDIX

A Technical Comparison of the Software

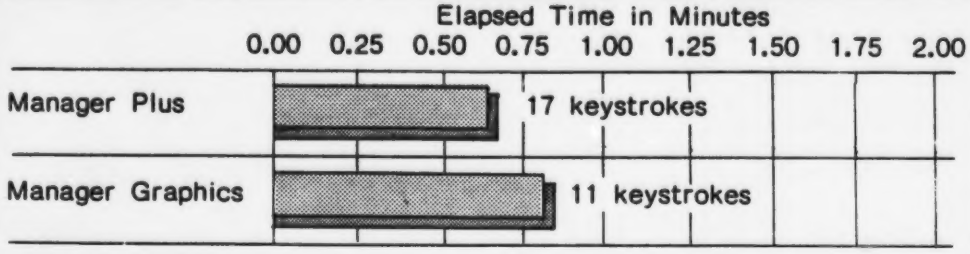
The following Appendix contains technical data related to a comparison between DART Manager Plus and DART Manager Graphics. It is a rather simple comparison of the effort and time involved in performing various tasks with the systems.

It should not used to decide which system best meets the needs of any operator. Operators who are interested in these programs should try the software themselves to decide which best meets their needs and which best fits into their way of doing things.

To obtain the data presented in the comparison, the programs were run on an IBM PC with two floppy disks. The information used as input for each task was exactly the same for each program. Each task was performed five times and the average was calculated and used in the illustrations.

TASK 4

Schedule the one-way trip outbound for the client



We positioned the cursor as if we had just finished booking the trip request and measured the elapsed time until the trip was scheduled on a vehicle. Vehicle itineraries were checked briefly before scheduling. All keystrokes were counted.